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Evaluation of Botanical Products as Stored Grain Protectants Against Rice weevil, (*Sitophilus oryzae* L.) in Paddy

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Abstract

The laboratory investigations on the evaluation of different plant products and vegetable oils against the rice weevil, Sitophilus oryzae *L. in paddy revealed that mustard oil at the concentration of 1.5 ml / 100 g seed proved its superiority over all other plant products in inducing higher mortality 3 days and 180 days after treatment. Similarly, the egg laying capacity, adult emergence and percent weight loss due to* S. oryzae *infestation was very low in the mustard oil treated seeds. Germination of the seeds was not effected by any of the treatments at 3 days and 180 days after treatment. Among all the treatments oils proved to be the best, followed by seed powders (15 g / 100 g seed). Hence it is concluded that oils especially mustard, neem and palm oil (@ 1.5 ml/ 100 g seed) in the order and as per availability may be recommended for checking* **Sitophilus oryzae *L.*** *infestation in stored paddy.*

Key words: Leaf powder, Paddy, Rice weevil, Seed powder*, Sitophilus oryzae and* Vegetable oil.

Introduction

Garlic (*Allium sativum* L.) is an important Spice crop cultivated all over the country during Rabi season except in Ooty hills of Tamil Nadu where it is grown during rainy season. India is the second major producer of Garlic having 2.01 lakh ha. area, 1058 lakh mt production and 5.27 t/ha productivity next after China. India exported 22665.99 mt. Garlic amounting Rs. 3957.75 lakh during 2012-13 (Anon., 2014).It is widely used in flavorings of food, preparation of chutneys, pickles, curry powder, tomato ketch-up etc. Besides nutritive values, it is included in Indian system of medicines (Ayurvedic, Unani and Siddha) as a carminative and gastric stimulant to help digestion and absorption of food (Sankaracharya, 1974). It is rich source of carbohydrates, proteins, phosphorus and volatile oil. Garlic crop is affected by various diseases of which, purple blotch caused by *Alternaria porri* (Ellis) Cif. is a major constraint and causes severe yield loss (Mishra *et al*., 2009). Spraying of broad spectrum fungicides like Thiram, Captan and Copper oxy chloride has been recommended for control of purple blotch of garlic. Control achieved by these chemicals is inadequate. Therefore, it is thought worthwhile to test the efficacy of more promising chemicals like Propineb-50 WP, Metiram-50 WP, Chlorothalonil-75 WP, Tebuconazole-25 EC, Hexaconazole-5 EC, Azoxystrobin-23 EC, Fenamidone-10 WP, Myclobutanil-10 WP against fungus. Not much light has been shed on biological control, botanicals which are effective against *Alternaria porri*. Hence, an attempt has been made to test commonly available botanicals and bio agents against the pathogen.

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Materials and Methods

a. In Vitro *Evaluation of Fungicides*

Ten fungicides were evaluated with different modes of action at recommended dose in the laboratory for their efficacy against *Alternaria porri* by the poisoned food technique (Nene and Thapliyal, 1979). The molten sterilized PDA was used as nutrient medium and required quantity of each fungicide was added separately so as to get a required concentration of that fungicide. The fungicides were thoroughly mixed by stirring and about 15 ml poisoned medium was poured to each of the 90 mm petri dishes and allowed for solidification. The actively growing periphery of 9 day old culture of *Alternaria porri* was carefully cut by using a gel cutter and transferred

aseptically to centre of each petri dish containing the poisoned solid medium. Suitable control was maintained by growing the cultures on PDA without the fungicides (Table-1). The plates were incubated at 27±1^{o}C for 9 days and the colony diameter was recorded 9 days after growth. Each treatment was replicated 3 times. The percent inhibition of mycelial growth over control was calculated using the formula of Vincent (1947).

$$I = \frac{C-T}{C}$$

I = per cent inhibition of mycelial growth

C = radial growth of fungus in control

T = radial growth of fungus in treatment.

b. In Vitro *Evaluation of Botanicals*

The fresh leaves and other parts of healthy plants were collected and thoroughly washed with tap water then air dried. Aqueous plant extract was prepared by grinding 100g leaves/other parts with 100ml distilled water (w/v) using a blender and filtrate was collected by passing through double layered muslin cloth. The supernatant was taken as standard plant extract solution (100%). All the extracts obtained were passed through filter paper used for assay. The poisoned food technique (Nene and Thapliyal, 1979) was followed to evaluate the efficacy of botanicals in laboratory against *Alternaria porri* at 15% concentration (Table-2).Each treatment was replicated 3 times. The method followed for conducting the experiment was same as that used for fungicide evaluation.

c. In Vitro *Evaluation of Bio-agents*

Interaction of eight antagonists were studied by following dual culture technique (Dennis and Webster, 1971). The interaction of *Alternaria porri* with antagonistic organisms were evaluated in the laboratory, 20 ml of PDA was poured into 90 mm petri dishes and allowed for solidification. Discs of 5 mm of *Alternaria porri* taken from 9 day old culture was placed at one end of the petri dish and respective antagonistic organisms were inoculated at the opposite side (Table 3). A control was maintained by inoculating only *Alternaria porri* at one end in case of fungal antagonistic. In case of bacterial antagonistic *Alternaria porri* was placed at both ends of petri plates and bacterial culture was inoculated at centre of the petri plate, control was maintained by inoculating *Alternaria porri* at the both the ends of the petri plates. Each treatment was replicated three times and incubated for 6 days at 27 ± 1^{0}C. The activity of antagonistic organisms were recorded by measuring the colony diameter of *Alternaria porri in* each treatment and compared with control.

d. Management of purple blotch, Alternaria porri

The field experiment was laid out in Randomized Complete Block Design with 13 treatments and 3 replications during *Rabi* 2013-14 and 2014-15 at College of Horticulture, Bidar, Karnataka. Healthy Rajalli gadde cultivar seedlings were planted in the field with 15cm X 10cm (row to row X plant to plant) spacing in plot size of 3.6 m X 1.8 m. All other cultural practices and pest control practices were followed as recommended in package of practices (Anonymous, 2013). The first spraying was carried out as soon as first symptom of disease was noticed in the field. Four sequential sprays of fungicides and botanicals were taken at an interval of 15 days (Table-4 and 5). Disease severity was recorded on ten randomly selected plants in each plot, just one day before each spraying and fifteen days after last spraying. Observations on severity of disease on foliage was recorded by using 0 to 5 point scale (Sharma, 1986) and PDI was worked out. The bulb yield in each plot was recorded and computed to hectare basis.

Scale	Severity
0	No disease symptoms
1	A few spots towards tip covering 1 to 10 per cent leaf area
2	Several dark purplish brown patch covering 11 to 20 percent leaf area
3	Several patches with paler outer zone covering 21 to 40 percent leaf area
4	Leaf streaks covering 41 to 75 per cent leaf area and breaking of the leaves from center
5	Leaf streaks covering more than 76% leaf area followed by complete drying and breaking of the leaves from the center.

Percent Disease Index was worked out as follows.

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of individual ratings X 100}}{\text{No. of plants or leaves examined X maximum disease grade}}$$

Results and Discussion

a. In Vitro *Evaluation of Fungicides*

The results indicated that significant difference among fungicides in inhibiting the growth of the *Alternaria porri*. Among ten fungicides were evaluated with different mode of action Azoxystrobin-

23 EC (93.60%) recorded maximum inhibition of mycelia growth of pathogen followed by Tebuconazole-25 EC (90.40%), Mancozeb-75 WP (82.34%), Propineb-50 WP (80.46%), Hexaconazole-5EC (76.57%), Fenamidone-10 WP (73.67%) and least inhibition was observed in Chlorothalonil-75 WP (47.44%) (Table 1). The results on the efficacy of Mancozeb-75 WP are in conformity with Chethana *et al.* (2011). The results are in agreement with Arunakumara (2006) who reported propineb-50 WP as effective fungicide against *A. solani* causing early blight of tomato. Chethana *et al.,* 2012 reported that Chlorothalonil-75 WP as less effective against *A. porri* in onion crop

Table 1: *In vitro* evaluation of fungicides against *Alternaria porri*

Treatments	Fungicides	Concentration (%)	% inhibition of mycelia growth
T1	Propineb -50WP	0.2	80.46[d]
T2	Metiram-50WP	0.2	58.43[h]
T3	Mancozeb-75WP	0.2	82.34[c]
T4	Chlorothalonil-75WP	0.2	47.44[i]
T5	Copper oxy chloride-50WP	0.3	72.04[g]
T6	Hexaconazole-5EC	0.1	76.57[e]
T7	Azoxystrobin-23EC	0.1	93.60[a]
T8	Fenamidone-10WP	0.1	73.67[f]
T9	Tebuconazole-25EC	0.1	90.40[b]
T10	Myclobutanil-10WP	0.1	72.74[fg]

Note: In the vertical columns means followed by same letters are not different statistically by Duncan Multiple Range Test (DMRT) (P=0.01).

b. In Vitro *Evaluation of Botanicals*

The results revealed that effect of plant extracts on the fungal growth was significant. The *Allium sativum* cloves extract was found effective in inhibiting the mycelia growth (64.64%) followed by *Clerodendron inerme* (57.10%), *Aloe vera* (55.14%), *Eucalyptus globes* (48.30%) and least inhibition was observed in *Glyricidia maculata* (26.04%) (Table 2). The results are in conformity with Mesta *et al.* (2011) where garlic clove extract was found effective in inhibiting the mycelial growth of *Alternaria solani* and *Alternaria helianthi* respectively. The effectiveness of garlic clove extract as a pesticide is due to volatile oil which contains dialyl disulphide, diallyl trisulphide and sulphodoxides derived from allicin (Vijayalakshmi *et al.,*1999). Pramodkumar (2007) reported *Clerodendron* leaf extract as one of the best plant extract in inhibiting the mycelial growth of *Alternaria porri.*

Table 2: *In vitro* evaluation of botanicals against *Alternaria porri*

Treatments	Botanicals	Plant Part Used	Concentration (%)	% inhibition of mycelia growth
T1	*Allium cepa*	Bulbs	15	28.47[i]
T2	*Allium sativum*	Cloves	15	64.64[a]
T3	*Clerodendron inerme*	Leaves	15	57.10[b]
T4	*Azadirachta indica*	Leaves	15	39.20[e]
T5	*Lantana camera*	Leaves	15	35.40[f]
T6	*Aloe vera*	Leaves	15	55.14[c]
T7	*Ocimum sanctum*	Leaves	15	33.87[g]
T8	*Glyricidia maculata*	Leaves	15	26.04[j]
T9	*Eucalyptus globes*	Leaves	15	48.30[d]
T10	*Durantha repens*	Leaves	15	31.40[h]

Note: In the vertical columns means followed by same letters are not different statistically by Duncan Multiple Range Test (DMRT) (P=0.01).

c. In Vitro *Evaluation of Bio-agents*

All the *Trichoderma* sp inhibited the growth of *Alternaria porri* effectively. Among these antagonists *Trichoderma harzianum* showed highest inhibition (56.00%) followed by *Trichoderma viride* (53.00%) (Table 3). Imtiaz and Lee (2008) reported *Trichoderma harzianum* and *Trichoderma virens* as most effective in inhibiting the growth of *Alternaria porri.*The next best antagonist was *Chaetomium globosum* with 42.00% inhibition of the pathogen. Vannacci and Harman (1987) have reported *Chaetomium globosum* as one of the effective antagonist of *Alternaria brassicola*. The entamopathogenic fungi *viz*., *Beauveria bassiana, Verticillium lecanii and Metarhizium anisopliae* were less effective and could inhibit the pathogen up to 23.00%, 21.00% and 17.00% respectively.Ineffectiveness of *B. bassiana* and other entomopathogenic fungi against *A. solani* maybe due to entomopathogenic nature (Anju Sharma *et al.,* 2010).

d. Management of purple blotch, Alternaria porri

In subsequent sprays all the fungicides and botanicals treated plots recorded significantly less percent disease index over control.During *Rabi* 2013-14 among fungicides 0.1% Tebuconazole-25 EC was significantly effective in reducing the disease intensity by recording a PDI of 20.00 and yield of 86.00q/ha (Table-4). 0.1% Azoxystrobin-23 EC, 0.2% Mancozeb-75 WP, 0.2% Propineb-50 WP, 0.1% Hexaconazole-5

Table 3: Effect of different antagonists on growth of *Alternaria porri*

Treatments	Antagonists	% inhibition of mycelia growth
T1	*Trichoderma harzianum*	56.00[a]
T2	*Trichoderma viride*	53.00[b]
T3	*Chaetomium globosum*	42.00[c]
T4	*Beauveria bassiana*	23.00[e]
T5	*Verticillium lecanii*	21.00[e]
T6	*Metarhizium anisopliae*	17.00[f]
T7	*Pseudomonas fluorescence*	21.00[e]
T8	*Bacillus subtilis*	31.67[d]

Note: In the vertical columns means followed by same letters are not different statistically by Duncan Multiple Range Test (DMRT) (P=0.01).

Table 4: Effect of different fungicides and botanicals on purple blotch of Garlic caused by *Alternaria porri* during – *Rabi*, 2013-14

Details of treatments	Mean PDI	Bulb yield (q/ha)	% yield increase over control
T1- 0.3% Copper oxy chloride -50WP	31.11[d]	74.50[f]	20.16
T2-0.2% Metiram-50WP	32.22[d]	72.57[g]	17.04
T3-0.2% Mancozeb-75WP	23.33[e]	82.44[c]	32.96
T4- 0.2%Propineb -50WP	24.44[e]	79.37[d]	28.01
T5-0.1%Hexaconazole-5EC	27.40[d]	76.43[e]	23.27
T6- 0.1%Azoxystrobin-25EC	21.11[ef]	83.94[b]	35.38
T7-0.1% Fenamidone-10WP	28.51[d]	78.44[d]	26.51
T8-0.1% Myclobutanil-10WP	30.00[d]	72.20[g]	16.45
T9-0.1%Tebuconazole-25EC	20.00[f]	86.00[a]	38.70
T10-15%*Allium sativum*	42.22[c]	66.60[i]	7.41
T11-15% *Aloe vera*	45.55[b]	68.30[h]	10.16
T12- 15% *Clerodendron inerme*	46.66[b]	64.70[j]	4.35
T13-Control	50.00[a]	62.00[k]	-

Note: In the vertical columns means followed by same letters are not different statistically by Duncan Multiple Range Test (DMRT) (P=0.05).

EC and 0.1% Fenamidone-10 WP were next best treatments found effective in reducing the disease intensity by recording a PDI of 21.11, 23.33,24.44, 27.40 and 28.51 and yield of 83.94q/ha, 82.44q/ha, 79.37q/ha, 76.43q/ha and 78.44q/ha respectively. Studies conducted by Wangikar *et al*., (2012) on management of purple blotch of onion in Marathawada region of Maharashtra revealed that lowest disease severity of purple blotch with spray of Mancozeb-75 WP at 0.25%, Hexaconazole-5 EC at 0.1% and Difenconazole-25 EC at 0.05%. Gupta et al., (2012) reported that systemic fungicides Tebuconazole-25 EC at 0.1% and Azoxystrobin-23 EC at 0.1% effectively controlled purple blotch disease of garlic. Among botanicals tested, PDI of 42.22 and yield of 66.60q/hq was recorded in *Allium sativum* cloves extract at 15% concentration. The results on the effectiveness of foliar application of *Allium sativum* cloves extract in the management of Alternaria blight are in conformity with Nashwa and Abo-Elyousr (2012). In the control plot highest PDI of 50.00 and yield of 62.00q/ha was recorded.

Table 5: Effect of different fungicides and botanicals on purple blotch of Garlic caused by *Alternaria porri* during – *Rabi*, 2014-15

Details of treatments	Mean PDI	Bulb yield (q/ha)	% yield increase over control
T1- 0.3% Copper oxy chloride -50WP	35.55[d]	73.83[e]	21.03
T2-0.2% Metiram-50WP	32.22[e]	70.36[f]	15.34
T3-0.2% Mancozeb-75WP	23.33[gh]	82.96[b]	36.00
T4- 0.2%Propineb -50WP	25.18[g]	79.40[c]	30.16
T5-0.1%Hexaconazole-5EC	26.54[g]	78.67[c]	28.96
T6- 0.1%Azoxystrobin-25EC	20.74[gh]	84.20[ab]	38.03
T7-0.1% Fenamidone-10WP	29.63[f]	76.23[d]	24.96
T8-0.1% Myclobutanil-10WP	27.77[fg]	71.44[f]	17.11
T9-0.1%Tebuconazole-25EC	22.22[gh]	84.50[a]	38.52
T10-15%*Allium sativum*	43.33[c]	68.20[g]	11.80
T11-15% *Aloe vera*	45.55[b]	65.83[h]	7.91
T12- 15% *Clerodendron inerme*	46.29[b]	64.53[h]	5.78
T13-Control	51.10[a]	61.00[i]	-

Note: In the vertical columns means followed by same letters are not different statistically by Duncan Multiple Range Test (DMRT) (P=0.05).

During *Rabi* 2014-15 among fungicides 0.1% Azoxystrobin-23 EC was significantly effective in reducing the disease intensity by recording a PDI of 20.74 and yield of 84.20q/ha (Table 5). 0.1% Tebuconazole-25 EC, 0.2% Mancozeb-75 WP, 0.2% Propineb-50 WP, 0.1% Hexaconazole-5 EC and 0.1% Myclobutanil-10 WP were next best treatments found effective in reducing the disease intensity by recording

a PDI of 22.22, 23.33, 25.18, 26.54 and 27.77 and yield of 84.50q/ha, 82.96q/ha, 79.40q/ha, 78.67q/ha and 71.44q/ha, respectively. Among botanicals tested, PDI of 43.33.00 and yield of 68.20 q/ha was recorded in *Allium sativum* cloves extract at 15% concentration. In the control plot highest PDI of 51.10 and yield of 61.00 q/ha was recorded.

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